
RENEWABLE ENERGY PENETRATION IN NIGERIA: A STUDY OF THE SOUTH-EAST ZONE

Uzoma, C. C. ; Nnaji, C. E; Ibeto, C.N.; Okpara, C.G.; Nwoke, O.O.; Obi, I.O.; Unachukwu, G. O and Oparaku, O. U.

National Centre for Energy Research and Development (NCERD), University of Nigeria, Nsukka.

ABSTRACT

This paper focuses on renewable energy penetration in Nigeria with emphasis on the South-East zone of the country. A data sourcing survey was done on renewable energy systems in the South-East zone and their locations by National Centre for Energy Research and Development (NCERD), University of Nigeria, Nsukka. Data from the survey obtained through questionnaire and interview methods are presented and analyzed using frequency counts and percentages. Based on available data, the paper concludes that renewable energy technologies have not significantly penetrated the energy scene of Nigeria's South-East zone. Regardless, solar photovoltaic is the only renewable energy application in use scoring a few points in some areas in the region. A policy drive is therefore needed to create the enabling environment for Renewable Energy Technologies to thrive in the region.

KEY WORDS: Renewable Energy, Renewable Energy Technologies, Penetration, Solar Photovoltaic, South-East Zone, Nigeria

INTRODUCTION

Renewable energy (RE) penetration in Nigeria is very difficult to assess. It is even more difficult when one considers the situation in the South-East geo-political zone of the country. This is because in a recent pre-study data sourcing on "Social Impacts of Renewable Energy on the Eastern Region" by the National Centre for Energy Research and Development (NCERD), University of Nigeria, Nsukka; official and coordinated information on RE systems in use across the region are not available. Even though there is unofficial knowledge of some renewable energy technology installations (especially, solar systems) in some states in the region, this cannot be officially ascertained or verified. For instance, it is known that there are solar photovoltaic lighting in Owerri-Nta and major streets in Owerri metropolis in Imo State, biogas system at abattoir in Awka-Etiti and solar water pumps in Awka both in Anambra State, small hydropower at Mgbo in Enugu State; these are not officially reported.

This paper is therefore an attempt to assess the level of penetration of renewable energy technologies in Nigeria, particularly in the South-East based on the field data obtained through the social impact pre-study. An overview of renewable energy resources that are available in the region is highlighted in section II below. Overall, the degree of renewable energy technology penetration in the South-East zone of Nigeria is presented.

OVERVIEW OF RENEWABLE ENERGY RESOURCES IN THE SOUTH-EAST GEO-POLITICAL ZONE OF NIGERIA

The importance of energy to economic growth and social development cannot be overemphasized. In fact, it is the mainstay of any nation's economy and sustainability. Sadly, the near-total dependence on fossil fuel for many years to propel the national economy has resulted in adverse problems of global warming and ecological degradation. Hence, the urgent need for alternative, but cleaner and safer energy sources is the most recurring global issue in present times. Tapping the world's vast renewable energy resources such as solar, wood, hydro etc is seen as the most viable and appropriate step towards salvaging our climate and ecosystems. This is because these energy resources are replaced naturally and can be used without the risk of them finishing (Hornby, 2005).

It is believed that ecological safety and climatic improvement would be achieved through drastic cut in fossil fuel consumption and vigorous harnessing of our abundant renewable energy potentials. Not much significant effort has been made so far to explore the vast renewable energy resources available in Nigeria which are: Photovoltaic Technology: A very common renewable energy technology is Photovoltaic Technology. This is the direct conversion of sunlight to electricity through photovoltaic cells. Photovoltaic, derived from (photo= light and voltaic= electricity), converts sunlight direct to electricity (Aldous, 2009.). The idea of direct conversion of

light to electricity, which is the basic meaning of the term photovoltaic originated long before its practical applications were, discovered (Strong *et al*, 1991.).

Despite the fact that Nigeria has abundant renewable energy potentials in solar, wind, biomass and small hydropower, the rate of penetration of these energy sources into the country's energy mix has been very slow. Only major-hydro plants currently supply about 29% of total national energy generation (Sambo, 2005.). This worsens the inadequate power situation in Nigeria, especially in the rural areas where most of the population lives: leaving them socially backward and their economic potentials virtually untapped.

So much has been said and written on renewable energy in Nigeria; from public perception, very little has been done in practical terms, particularly in the South-East. Perhaps there are few installations for private household users in the informal sector, but lack of a vigorous policy plan still hampers vast public-based renewable energy projects to stimulate local economic growth. Among the reasons for almost a lack of renewable energy resources consciousness and presence in eastern Nigeria are: a low level of awareness of the socio-economic and environmental benefits of RE technologies and lack of policy initiative in that direction. Although our study revealed the existence of solar-powered cold stores for vaccine storage across some Eastern States under the National Programme on Immunization (NPI), this is yet to be verified. Besides, whether the rural communities where the de facto applications are installed understand the essence and benefits of the systems is another matter to unravel.

Biomass- 'this is used to refer to energy derivable from sources of plant origin such as trees, grasses, agricultural crops and their derivatives, as well as animal wastes. Biomass may be used as solid fuel or converted to liquid or gaseous forms to generate electric power, heat or fuel for motive power. It is considered renewable as it is naturally occurring and may be harvested without significant depletion when properly managed' (Sambo, 2009). Biomass resources available in the South- East include: forest residue with the abundance of rain forests, farm wastes and crop residue, animal dung and poultry droppings, industrial effluents (the industrial cities of Onitsha, Aba and Nnewi), urban wastes and sewages. Solid biomass materials can be converted to gas on the one hand. On the other hand, bio-fuel can be generated through energy plants like *Jatropha*; this will immensely improve climatic conditions and protect against health hazards associated with carbon emission through fossil fuel use or direct fuel wood combustion in poorly ventilated household kitchens. At NCERD-UNN, biogas digester applications and cook stoves are available for domestic use. In other regions of Nigeria, biogas projects are also in use at National Animal Production Research Institute (NAPRI), Zaria; Mayflower Secondary School, Ikenne, Ogun State and Ojokoro/Ifelodun Cooperative Agricultural Multipurpose Society in Lagos State (Sambo, 2009.). However, only one biogas system for cooking gas generation was captured in the pre-study on "Social Impacts" in Abia State, which is a strong indication that this technology is not yet known nor diffused in the South-East zone.

Small Hydropower (SHP) - a small hydropower is a system of hydropower (energy derived from water) with an installed capacity of between 2 and 10 MW. Recent studies done in 12 states and 4 river basins captured over 278 SHP sites with total potentials of 734.3 MW. SHP potential sites exist in virtually all parts of Nigeria with an estimated capacity of 3,500 MW (Sambo, 2009.). Much of Nigeria's current energy base is on hydropower from at least three major dams (Kianji, Shiroro and Ikom), which account for about 29% (Sambo, 2005) of the national energy supply at present. Meanwhile, the overall hydropower resource potentially exploitable in Nigeria is in excess of 11,000 MW (Sambo, 2005.). The eastern region can indeed take its' share of these estimates. For example, the Chinese Embassy in Nigeria offered to assist Nigeria in electro-mechanical equipment for a 30 kW SHP demonstration project at Anambra-Imo River basin in Abia State (Sambo, 2009), but this is either not yet realized or under-reported since no such data was obtained in our study.

Solar Energy- this simply means energy generated from the sun in the form of electricity (solar PV) or heat for cooking, drying or heating (solar thermal). The average sunshine hours are estimated at 6hrs per day in Nigeria. This is fairly well distributed across the country with the minimum average of about 3.55 kWhm⁻²day⁻¹ for Katsina in January, 3.4 kWhm⁻²day⁻¹ for Calabar in August and a maximum average of 8.0 kWhm⁻²day⁻¹ elsewhere in May. It is thus assumed that if solar collectors or modules were used to cover 1% of Nigeria's land area of 923,773km², it is possible to generate 1850×103GWh of solar electricity per year (Sambo, 2009.). The South-East can once more take its' fair share of these estimates. Areas of solar electricity application that are popular in Nigeria in general and the South-East in particular include: water pumps, street lighting and NPI-sponsored vaccine refrigeration, albeit, this technology cannot be said to be widespread since there is not yet any proven positive effect on the socio-economic life of easterners. Even though most pre-study data are on solar,

the status of any of the information is yet to be ascertained. Nevertheless, solar thermal applications are also available for cooking, water heating, crop drying, incubators and chick brooding (NCERD, 2008.) at National Centre for Energy Research and Development, University of Nigeria, Nsukka.

Wind Energy- this refers to the kinetic energy in a flow of air through a unit area perpendicular to the direction of the wind, which can be harnessed by a wind machine for useful purposes (Walker and Jenkins, 1997.). Simply put, wind power is the conversion of wind energy into a useful form of energy, such as electricity, using wind turbines (Ogunleye, 2009.). Aside the coastal area and offshore, the wind regime in Nigeria is moderate in the South, but stronger in the hilly regions of the North. Studies by the Federal Ministry of Science and Technology (FMST) have identified possible sites for viable wind energy projects across Nigeria with great potentials (Ogunleye, 2009.). The South-East can also take a fair share with Anambra, Imo and Enugu States mentioned in the FMSTs studies. Several researchers have shown that in areas with annual mean wind speeds of 3.5m/s- 4.0m/s or greater, wind power systems can usually deliver electricity or pump water at costs lower than photo-voltaic, diesels, or grid –extension (Ogunleye, 2009).The significant penetration of wind energy in the South-East energy scene and entire Nigeria is desirable, because it is plentiful, renewable, widely distributed and clean. Wind energy technology is yet to arrive in the region, as no single wind power system is presently extant. However, ‘it suffices to point out that wind energy technologies have previously been tried for water pumping from open wells in many secondary schools in old northern Nigeria. A 5kW electricity conversion system for village electrification is presently in use at Sayyan Gidan Gada, Sokoto State’ (Ogunleye, 2009.).

The South-East zone can boast of great potential for renewable energy technologies in solar, biomass, small hydropower, as well as wind. Great potentials also exist in human resource to harness these resources for the socio-economic well being of the region. What is really lacking is the policy drive and collaborations of stake holders in the industry for vigorous and effective exploitation of these vast renewable energy opportunities.

MATERIALS AND METHODS

This paper is based on pre-study survey on ‘Social Impacts of Renewable Energy on the Eastern Region’. Questionnaires were administered as the main instrument of data collection. Oral questioning was also used in some cases to obtain necessary information. The data can however be considered as primary data; even though some of the data were handed down as information already generated from few official sources.

On the whole, some relevant ministries, parastatals and agencies in the states of the South-East zone namely- Abia, Anambra, Ebonyi, Enugu and Imo were selected for questionnaire administration. The data are presented and analyzed using frequency counts and percentages.

RESULTS AND DISCUSSION

Table 1.Penetration of renewable energy technologies in the South-East Zone of Nigeria.

State	Identified sites for Solar energy systems	Biogas plant	Wind	Hydropower	Total	Percentages
Abia	9	1	-	-	10	10.53
Anambra	26	-	-	-	26	27.37
Ebonyi	19	-	-	-	19	20
Enugu	17	-	-	-	17	17.89
Imo	23	-	-	-	23	24.21
Total	94	1	-	-	95	
Percentage	98.95	1.05	-	-	100	

Source: compiled from pre-study data

Data on the availability or existence of renewable energy technologies in Nigeria’s South-East Zone obtained through the pre-study are compiled in Table 1 .

While highlighting renewable energy resources in Nigeria as solar energy, biomass, wind and hydro resources, the result from the study indicates that only solar energy technology has made an entry into the East’s energy scene (98.95%) with several applications (lighting, water pumps and refrigeration) being powered by solar PV cells, but this does not in anyway suggest any penetration of solar energy technology in the region or Nigeria in general compared with overall energy needs. Nonetheless, Illoeje (2002) acknowledges that no other modern RE

technology is anywhere near the usage or number and capacity of installations in the country as solar-PV. In his survey of activities in solar PV in the country up to 1999, a total of 316 installations amounting to 238.8kWp, were identified nationwide. Conversely, a few number of other RE technologies (wind, biogas, and hydropower) were identified. Of the 316 installations, there was at least one in 26 out of the 36 states and the FCT. Lagos (23.6%), Yobe (16.3%), Kano (8/6%) and Akwa-Ibom (8.6%) States had the highest number of installations, while many States in the South-East region were among those with the lowest number of installations. The presence of only one biogas system was reported in Abia State while other renewable energy systems (wind and hydro) recorded zero data regarding their entrance into the South-East energy scene based on the frequency distribution below. Thus, the study also indicates that wind energy does not exist in South-East corroborating the results of previous studies on wind power installations, which discovered very few wind power projects only in northern region indicating very limited penetration in Nigeria as a whole (Ojosu and Salawu 1990, Energetic Solutions, 2004.).

Table 2. Distribution of solar energy penetration in the South-East.

States	Vaccine refrigeration at Health centers	Home/street lighting	Water pumping	Powering Equipments	Total	Percentage
Abia	-	8	1	-	9	9.57
Anambra	21	4	-	1	26	27.66
Ebonyi	13	4	1	1	19	20.21
Enugu	17	-	-	-	17	18.09
Imo	-	4	19**	-	23	24.47
Total	51	20	21	2	94	100
Percentage	54.25	21.28	22.34	2.13		

Source: compiled from pre-study survey

** indicates that out of the 19 solar water projects in Imo State, 7 are awaiting commissioning; work is in progress in 4; 1 is out of site; 1 has been abandoned while the remaining projects have been completed (Niger Delta Development Commission, Imo State.).

In relation to total RE penetration in the South-East, data on Table 2 shows that solar energy is the most common with Anambra State recording the highest solar energy presence in the region (26 sites / 26.53%). This is followed by Imo, Ebonyi, Enugu and Abia States with 23 sites/24.47%, 19 sites/20.21%, 17 sites/18.09% and 9 sites/9.57%, respectively. Table 2 also indicates that solar photovoltaic systems are utilized for vaccine refrigeration at Health Centers of Local Government Areas in Anambra, Ebonyi and Enugu States under the NPI (National Programme on Immunization), home and street lighting, powering office equipment like computers and water pumping. Analysis of the frequency counts thus shows that Solar PV is utilized mostly for vaccine refrigeration at NPI cold stores in these states (54.25%), while 21.28%, 22.34%, and 2.13% represent photovoltaic application for home and street lighting, water pumps, and equipment powering respectively. Hence, solar PV energy can be adjudged the most dominant renewable energy resource in the whole eastern region based on the pre-study finding. Nonetheless, the degree is too low to be of any socio-economic use to the South-East.

With respect to biogas, only one biogas plant was recorded in the eastern region and that is in Abia State, representing only one percent of the total renewable energy technology deployment in the whole South-East. The pre-study findings also show that wind power and small-hydro power are non-existent in the zone as no project was reported for them. It can therefore be said categorically that both wind and small-hydro resources have a zero presence in the eastern region.

CONCLUSION

Nigeria is endowed with abundance of renewable energy resources in solar, small-hydro, biomass and wind. The South-East especially has a fair share of the overall distribution of these RE resources that can be harnessed to stimulate economic growth and social development of the zone. Incidentally, the deployment of RE

technologies in the region to exploit these renewable energy sources is yet to attain any significant level; even though much has been said and written on renewable energy given the staggering effects of climate change and ecological degradation. The pre-study by NCERD-UNN corroborates this position as findings show that only few RE systems (mainly solar) are deployed across the five states of the zone (Abia, Anambra, Ebonyi, Enugu and Imo) with little or no socio-economic significance so far in the region. The pre-study also reveals that the solar applications are used for lighting, water pumps or vaccine refrigeration at local government headquarters under the auspices of the NPI. Moreover, apart from the major-hydro dams with current supply of about 29% nationwide afore-mentioned, no other renewable energy resource and not even the small-hydro has made significant entry into the national grid or the South-East zone of Nigeria.

Renewable energy technologies (RETs) portend the best possibilities of connecting isolated communities to the national grid and to induce local economic growth that would culminate in socio-economic development of the South-East and Nigeria in general. Thus, a policy drive is needed to create the enabling environment for RETs to thrive in the region.

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- Corresponding Author:
Nnaji, C. E,
National Centre for Energy Research and Development (NCERD), University of Nigeria, Nsukka.